STUDENT PROJECT FUNDS APPLICATION SUMMARY

This form serves as a cover sheet for your actual proposal. It is required of all applicants.

NOTE: 1) This form must be clear and legible. 2) Do not say "See Attached" when asked for information. At least a summary of the answer is required. 3) Include the checklist. 4) Submit original and one copy of the entire proposal using this form as the cover sheet on each.
SUBMIT PROPOSAL (including completed checklist and letters of support) **BY 3:30 p.m. ON OR BEFORE THE DUE DATE TO YOUR COLLEGE OFFICE.**

Keep a copy for your records.

Name of Lead Student: David Goodman

College: Kresge Phone: 714-363-1280

Complete Mailing Address: 118 Hainline Rd Aptos, CA 95003

(Award letter will be sent to this address. Notify college of address changes.)

Project Title: Autonomous Lifeguard

Project Category: Research (robotics engineering, emergency response)

Research (Specify academic area)

Public Event (Include date, location)

Brief Abstract (Please limit length to this space): As a senior capstone design project, an ambitious group of my peers and I are building an autonomous surface vessel that will aid a lifeguard on the beach in order to save someone from drowning. Our project allows a lifeguard to quickly target a drowning person with a magnifying scope that will obtain their GPS coordinates and communicate them to an autonomous boat located in the water beyond the shore breaks. The boat will autonomously navigate to the person, allowing the drowning individual to hang on and stay afloat until the lifeguard arrives.

Total Budget for this project $ 3535.42

Funds requested / received from other sources* $ ______ from ______

$ ______ From ______

$ ______ From ______

Amount requested from Student Project Funds $ 450.00

*If no other funding has been received or requested, please explain what efforts have been made. We have attempted to contact the CITRIS institute for funding, however their budget is very limited and they were unable to offer funding. We will continue to search for funding from colleges and other organizations.

Are you willing to release your proposal and the results of your proposal as sample material for others writing proposals?

Yes.

Checklist

Include one copy of this sheet with your original proposal.

Please check each of the following items to be sure your proposal is in compliance with the guidelines.

Please answer the following questions with a "yes" or "no":

yes 1. Are you an undergraduate student?

yes 2. Are you a currently registered student and will you continue to be when funds are used?

no 3. Has this project been previously funded by this funding source?

no 4. Is this project an ongoing/annual event or project?

no 5. Has this project been completed?

no 6. Is the proposal for an Education Abroad Program or any other formal extramural education program?

yes 7. Is a complete itemized budget included?

no 8. Is the proposal a request for class enrollment fees?

no 9. Does the proposal budget include payment of salaries?

no 10. Is the proposal for personal living expenses?

no 11. Is the proposal for your travel in connection with a paper or presentation?

no 12. Is the travel in connection with some other activity?

yes 13. Are letter(s) of support included with proposal? **(NO LATE ADDENDUM TO PROPOSALS WILL BE ACCEPTED.)**

no 14. Thesis project? Has relevant Board/Division been consulted for funding? (Please attach Dept. statement)

yes 15. Has the typed Application Summary form been used as the cover sheet of the proposal?

yes 16. Is one copy of complete proposal (in addition to original) attached?

yes 17. Have you reviewed this proposal with anyone?

Who: Lydia Zendejas

David Goodman — Applicant's Signature

1/17/2013 — Date

Autonomous Lifeguard

Student Project Funds Proposal

Abstract

In the United States, there have been a reported 99 people that have drowned in the past year alone, with a good number of them occurring while a lifeguard was on duty. In that year, there were 63,000 individual cases where Lifeguards rescued people at risk of drowning. We are proposing an autonomous surface vehicle to aid and assist these drowning individuals during the critical minutes before help can reach them.

Our project allows a lifeguard to quickly target a drowning person with a magnifying scope that will obtain their GPS coordinates and communicate them to a boat located in the water beyond the shore break. The boat will autonomously navigate to the person, allowing them to hang on and stay afloat until the lifeguard arrives. This project aims to keep beaches safer by reducing the risk of drowning.

Narrative

Background

The city of Los Angeles has employed the use of a device named EMILY (Emergency Integrated Lifesaving Lanyard) on their state beaches to save drowning victims. The device is deployed from the shore and remotely controlled by a human operator. Although it offers a degree of assistance, there exist multiple drawbacks to the system as a whole. The first is that it requires an operator, meaning that a lifeguard will be occupied with controlling the device during a rescue. The second is that the device must fight against the waves in order to reach the victim. This implies an unpredictable delay when navigating to the victim. The third drawback is that the device is limited by the field of view and skill of the operator.

We propose a fully autonomous system that will navigate to the location of a drowning victim, offering assistance as a lifeguard is deployed from shore. This eliminates the need for a human operator, allowing the lifeguard to swim out to the victim as the device navigates to the victim. The device will be stationed within the water at a certain distance from the shore and beyond the wave breaks so that it may arrive at a drowning victim's location swiftly.

Objective

Motivated by the number of drowning cases each year, The Autonomous Lifeguard Senior Design Group aims to develop an assistive, life-preserving, vessel with the capability of navigating to and locating drowning individuals in open water. This vessel, the Autonomous Lifeguard Assistant (AtLAs), will be stationed in the open water on a beach or in a lake. The AtLAs will be coupled with an onshore control tower, the Command Post Acquisition System (ComPAS), that transmits the GPS coordinates of drowning individuals that have been spotted by a lifeguard. While the lifeguard swims to the drowning individual, the AtLAs will use its triple motor propulsion system to arrive at the victim's location at least three times as fast as a lifeguard can. Furthermore, the entire Autonomous Lifeguard System is designed to be a useful and affordable product for the public. The ultimate goal is to create a practical and superior aquatic life-saving system.

Procedure

This project is composed of two systems, a command center (ComPAS) and Autonomous Lifeguard Assistant (AtLAs), which will communicate with each other over a wireless protocol. The ComPAS consists of a GPS-equipped scope mounted on a lifeguard post. When the lifeguard sees someone who is drowning, he or she will spot them through the scope and press a button. At that instant, the coordinate location of the victim will be obtained–through triangulation algorithms and a global coordinate system provided by the GPS–and sent to the AtLAs in the water. The AtLAs will then begin to self navigate to the location using its own on-board GPS device as well as an array of sensors for detecting the person. Upon reaching this destination, the AtLAs will intelligently traverse the area until it finds the drowning victim. The AtLAs will support the victim and allow them to rest while the lifeguard makes their way out.

In order to accomplish our objective, we propose a three phase approach: design, integration, and testing. In the design stage, which we are currently in, a majority of the research was accomplished to establish a solution to the task and physical and mathematical models were created to allow for an enlightened analysis of the proposed solution. Next, the models established in the design phase are to be rigorously examined in the testing phase to acquire real data to prove the accuracy and robustness of the model. Lastly, the integration stage, in which the minimum specifications will be addressed, involves assembling the final product by combining all the refined modules into a physical implementation that meets the specifications. These three phases encompass the life of the project.

Since mid-November, our team has made significant progress in completing the research and design phase for our project. We began by doing extensive background research related to the sensors and actuators, as well as the basic physical capabilities required. This led to modeling and physical calculation related to the buoyancy, hydrodynamics, motors, power budget, sensor specifications, and the accuracy of our navigation system. Using this research, we formulated various initial solutions, and then, with the input of trusted and qualified mentors, proceeded to amend, revise, and ultimately converge onto an effective solution. Next, we completed a group charter, an itemized budget, a Gantt chart, a project proposal, and have already given two presentations to audiences composed of engineering professors and students. In order to complete the design stage, we are in the process of designing physical prototypes of the ComPAS and the AtLAs and have already ordered and received a majority of the sensors we will be using. This first stage is nearly complete, and once we are done we will be ready to integrate our prototypes into a cohesive product.

The next phase is integration. In the integration phase, we will be combining the working prototypes from the design phase into a complete product. This will involve finalizing the ComPAS and improving its robustness for transportation to the test location. The AtLAs will also need to be assembled and finalized, outfitted with buoyancy foam and protective boat fenders, and cleared for use in lakes and oceans. Also, we will need to reinforce both the AtLAs and the ComPAS and ensure that they are properly waterproofed and protected against the elements. Once the integration of our systems is complete, we can begin testing and assessing the performance of the systems.

The testing phase is the third and final stage. It includes a thorough investigation of our assembled systems and their ability to meet the established objectives. Unit tests have been created that will help streamline this process and prevent fixes from being introduced that adversely affect another piece of the system without being detected. As a final test, we will place the ComPAS on the shore of a lake or beach in Santa Cruz, deploy the AtLAs from the water, and then use the ComPAS and AtLAs to save a "drowning" volunteer. Once our system passes this minimum specification we will have completed our project.

Qualifications

Darrel Deo is our team leader. He will also be working on integrating the sensors and building the tripod, which will be used to obtain the GPS coordinates of the drowning victim. Darrel is qualified for this position because of his work at MIT. While at MIT, Darrel worked with the Robotics, Vision, and Sensor Networks Group (RVSN) where he helped develop an assistive device for the visually impaired. This experience makes him well qualified for leading our team, and handling the sensor integration for the project.

Shehadeh Dajani is managing our budget. He will also be leading our Printed Circuit Board (PCB) design and layout, along with our vehicle design. Shehadeh is qualified for these positions because he has taken a course on PCB design and designed numerous PCBs both educationally and industrially. Shehadeh has also had previous experience with ROVs, at the University of Maryland. Finally, Shehadeh will be heading the human detection portion of the project by working with Darrel to design and modify existing sensors for aquatic human detection.

John Ash is managing our schedule for the project. He will also be working on the wireless protocols, water proofing, and PCB fabrication. John is qualified for these positions because of his previous experience with point-to-point communications. His experience with the autonomous solar boat on campus in the Autonomous Systems Lab (ASL) makes him an excellent consultant for protecting our hardware from water. Furthermore, John has hands-on experience fabricating PCBs.

David Goodman is our document administrator. He will also be developing the Finite State Machine (FSM) for our robot and the navigation system. David is more than qualified for this position, because he has five years of software engineering experience in industry. He is able to oversee design and testing of the software portion of our project. David has also worked in the ASL on the boat project, and with a graduate student on GPS-related research for the lab. David has the necessary experience to head the design and implementation of the software navigation system for our project.

Benefits

This project will directly benefit the Santa Cruz community, as well as any coastal community around the world, by assisting a lifeguard to be more effective at saving people from drowning. Furthermore, the target budget for the Autonomous Lifeguard System, including research, is aimed at making this project a sensible and affordable end product that has the real opportunity to be used. The project is established in a way to allow for expansion from the original scope so that the AtLAs can be used for search and rescue or patrolling situations. Overall, we plan on using our engineering skills and talents to design a product with the sole purpose of saving lives and reducing the risk of drowning across the globe.

Autonomous Lifeguard Project

Itemized Budget

Item #	Qty	Cost (each)	Description	Part #	Manufacturer	Vendor	Category	Notes
1	2	$173.63	45" RC Boat Hull (Giant Racer G-75 Mosquito Craft)	B757T6030	STOP	amazon	Aquatic	Going to test, then possibly modify or return.
2	4	$30.00	RC Boat Fender Skirt (Polyform G-4 Twin Eye Fender 6.5 x 23 - Black w/Air Adapter)	G-4-BLACK	Polyform	Boater's Marine Supply	Aquatic	
3	1	$105.00	Polyurethane Expanding Foam (2 gal kit 50/50 mix)		Various	Boat Builder Central	Aquatic	480 lbs of buoyancy U.S. Coast Guard Approved
4	3	$53.09	AquaCraft 28-35-2200kV Brushless Motor MiniMono	AQUB1805	AquaCraft	Tower Hobbies	Aquatic	
5	3	$28.69	Aquacraft Grim Racer 40X52/3, 3 Blade Prop, LH	AQUB9720	AquaCraft	funrcboats	Aquatic	40mm (1.57") x 52MM Pitch. Copper-Beryllium-Titanium. Must hand finish.
6	2	$53.09	AquaCraft 20-Amp LiPo ESC Minimono	LXBHKP	AquaCraft	Tower Hobbies	Aquatic, Power	20 Amp
7	2	$70.82	Turnigy nano-tech 5000mah 4S 45~90C Lipo Battery Pack	N5000.4S.45	TURNIGY	Hobby King	Power	5000mAh, 4 Cell (14.8V), 45C Constant / 90C Burst
8	2	$128.83	Waterproof NEMA 4X enclosure	HW-J161406SC	Nema	automationdirect	Aquatic	4SCREWS OPQ CVR GRY 4X 16X14X6IN
9	2	$91.88	3DR GPS uBlox LEA-6 Breakout	LEA-6H	uBlox	3drobotics	Navigation	UART, USB interfaces. Includes ceramic antenna, LNA, SAW filter, and 3.3V batt.
10	2	$31.50	Barometric Pressure Sensor - BMP085 Breakout	SEN-11282	Bosch	sparkfun	Navigation	I2C interface. Piezoelectric, includes temp. sensor.
11	1	$18.04	Triple Axis Accelerometer Breakout	MMA8452Q	Freescale Semi	sparkfun	Navigation	I2C interface. 3-axis, 2 ISR pins, optional HPF.
12	1	$61.18	Triple-Axis Digital-Output Gyro ITG-3200 Breakout	ITG-3200	InvenSense	sparkfun	Navigation	I2C interface. 3-axis, optional LPF, and ISR pin.
13	1	$246.26	Barska Blackhawk ED Spotting Scope 20-60x 60mm Angled Body	AD11520	Barska	midwayusa	Navigation	Great at 600-800ft. 60mm, 20-60x.
14	1	$96.19	Vortex High Country Backpack Tripod	HCOUNTRY	Vortex	midwayusa	Navigation	Full size, 4.48 ft tall, 2.1 lbs.
15	4	$22.51	12-bit Absolute Magnetic Rotary Encoder with SSI and PWM Output incl. Diagnostic Functions	AS5045-ASST	ams	ams	Navigation	Absolute position sensing with 0.09 deg resolution.
16	2	$73.35	MLX90620 FIRray:16X4 Far InfraRed Array	MLX90620	Melexis	Future Electronics	Navigation	I2C interface. ~23 ft range.

Autonomous Lifeguard Project

Itemized Budget

Item #	Qty	Cost (each)	Description	Part #	Manufacturer	Vendor	Category	Notes
17	4	$20.03	Infrared Proximity Sensor - Sharp GP2Y0A21YK	SEN-00242	Sharp	sparkfun	Navigation	2.6 ft.
18	1	$42.89	XBee Pro 60mW U.FL Connection - Series 1 (802.15.4)	WRL-08710	Digi	sparkfun	Communication	UART interface. External antenna, 1 mi range, 250 kbps max
19	2	$42.89	XBee Pro 60mW PCB Antenna - Series 1 (802.15.4)	WRL-11216	Digi	sparkfun	Communication	UART interface. PCB antenna, 1 mi range, 250 kbps max
20	3	$5.18	Breakout Board for XBee Module	BOB-08276		sparkfun	Communication	Convert to standard pin spacing.
21	8	$3.08	2mm 10pin XBee Socket	PRT-08272		sparkfun	Communication	XBee standoffs for breakout board.
22	1	$7.33	2.4GHz Antenna - Adhesive (U.FL connector)	WRL-11320	TE Connectivity	sparkfun	Communication	2.4 GHz, 2 dB gain
23	1	$65.12	RFID Excalibur K9classicedp K9 Alarm	K9CLASSICEDP	Excalibur	amazon	Communication	Returns rover to base waypoint. Shah tested 50 ft range.
24	1	$56.30	Super High Intensity LED Waterproof Emergency Strobe Light (BLUE/RED)	PSZLEDSTB0421-BR	OLS	amazon	Communication	12V/24V: 100mA - 660mA/50mA - 330mA
25	2	$5.42	Anti-Theft High dB Lond Mini Piezo Siren for Car Alarm	B00A8DGAMQ	BestDeal USA	amazon	Communication	12V DC, 150mA/90V DC, 90mA, waterproof
26	4	$60.00	Board Runs				Other	
27	1	$150.00	Discrete Components				Other	
28	1	$200.00	Materials				Other	Steel, coating, acrylic, wood, MDF, foam
29	4	$11.96	PIC32MX320F128H uController	PIC32MX320F128H	Microchip	microchipdirect	Other	80 MHz, 16 KB RAM, 2 I2C/SPI/UART, 16 A/D, 5 timer/PWM, 2 comp., 53 I/O
30	3	38.04	chipKIT Uno32	CHIPKIT UNO32	Microchip	digilentinc	Other	PIC32MX320F128 for prototyping.
31		$166.65	Continuancy (5%)					Cushion for unforseen events such as additional parts and rush delivery.
Total		3535.42						

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JACK BASKIN SCHOOL OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT
ENGINEERING 2 BUILDING

SANTA CRUZ, CALIFORNIA 95064
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(831)459-4482 FAX

Kresge Project Fund Review Committee,

January 15, 2013

I would like to enthusiastically recommend John Ash, Darrel Deo, Shehadeh Dajani, and David Goodman for Kresge Student Project Funds assistance with their project: the Autonomous Lifeguard. This is an ambitious project that has real world application with the potential to save lives. This group is dedicated, has the requisite skills, and I am actively mentoring them on the project. I have taught challenging courses where each of them have stood out as bright individuals who are among the top in their class. Their history of success in my classes and in my lab demonstrates the proficiency necessary for success with this project.

Initially, the students approached me for advice and input concerning their project; and I have agreed to mentor them. They have been hard at work, making progress even over the winter break.

All four students have taken an introduction to mechatronic design course that I teach. The curriculum consists of challenging lab exercises and a demanding final project. The project requires the students to work in teams of three to construct autonomous robots to compete with each other in a game of capture the flag, all while earning points by striking each other with ping pong balls. All did well on the project, and two are current tutors for the class.

These students are ambitious, hardworking, and capable. I believe their project has every chance of success and that they will do their utmost to ensure it.

Please do not hesitate to contact me if you have an need for further information.

Sincerely,

Gabriel Hugh Elkaim

Gabriel Hugh Elkaim
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January 17, 2013

To Whom It May Concern:

As Undergraduate Advisor to the Baskin School of Engineering and Director of the Multicultural Engineering Program (MEP), I meet with many undergraduate engineers throughout their careers at UCSC. This group of engineering students has the dedication and skill to successfully complete the Undergraduate Senior Design project they have chosen. I am confident that each team member, John Ash, Shehadeh Dajani (current MEP member), Darrel Deo, and David Goodman, has the expertise needed to accomplish their task. I have full faith in these students and I would like to forward this recommendation to the Kresge Student Project Funds program to support them in their senior design project. Individually, the members of the group have each shown excellence in their engineering abilities, the students excelled in their classes, work environment, and have shown a devoted interest in continued work in their respective fields.

The project itself is a credible and commendable proposal; an autonomous life-craft with the capability of self-navigating to a drowning individual. Besides endorsing the team itself, I also have support for creating this potential product that has practical and noteworthy implications. At the Jack Baskin School of Engineering, we try to instill an initiative to engineer products that will leave a beneficial footprint on the world and nurture a constructive engineering society. The Autonomous Lifeguard Project and its members aim to do just that and I am very optimistic about it.

As I mentioned earlier, I have seen many students come through my office and these individuals are intelligent and enthusiastic, evident through their success in past classes, recommendations from previous Professors, and extra-curricular activities. I have no doubt that the project they are pursuing will result in both successful and novel outcomes.

Lydia Zendejas

Lydia Zendejas
MEP Director & Undergraduate Advisor